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SEPTEMBER GENERAL MEETING OF THE DEPARTMENT OF TECHNICAL SCIENCES

- USSR -

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SEPTEMBER GENERAL MEETING OF THE DEPARTMENT OF TECHNICAL SCIENCES

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On 29 September 1959, a general meeting of the Department of Technical Sciences of the Academy of Sciences USSR was held under the chairmanship of Academician L. D. Shevyakov. First heard was a report by N. V. Mel'nikov, corresponding member of the Academy of Sciences USSR, on basic improvements in the technology of ore mining by the open-pit method.

The mining industry plays an important role in the program for the development of the national economy of the USSR during the current Seven-Year Plan, approved at the historic 21st Congress of the CPSU. The open-pit method for the exploitation of ore deposits plays a significant role in the development of the mining industry. In 1958, approximately 20% of the coal, 60% of the iron ore, over 50% of nonferrous metal ores and 100% of building materials were extracted by open-pit methods.

As the speaker pointed out, due to the extensive use and improvement of progressive open-pit mining methods, the development of the mining industry has resulted in tremendous labor savings and has made it possible to obtain, within a very short period of time, a maximum effect from recently launched and reconstructed mining enterprises.

The speaker presented the following data: by using open-pit methods for the extraction of coal, the labor productivity is 3 to 5 times higher than in the shaft method; in the extraction of copper ore, the labor productivity is 9.8 times higher; in the mining of nickel-cobalt ore, it is 4.5 times higher; in the mining of lead ore, it is 5.5 times higher; in case of aluminum ores, it is 7 times higher; in case of tungsten-molybdenum ores, it is 6.8 times higher, and in case of tin ores, it is 8 times higher; the net cost per ton of ore is 3 to 4 times lower, the time required for building the mining enterprises is reduced by 1.5 to 2.0 times, and capital investments are reduced by 1.5 times in comparison to the shaft mining method. In the coal industry alone, as a result of the difference in the net cost of

coal extracted by the open-pit and underground methods, annual savings of 2.5 billion rubles will be achieved by 1965 and 100,000 less workers will be needed for the extraction of the planned amount of coal.

Major objectives in the open-pit mining of ores during the current Seven-Year Plan include deposits in the Kursk magnetic anomaly, the iron ore deposits of Kustanay Oblast and Krivoy Rog, the Gaysk copper ore deposits, the coal deposits in Krasnoyarsk Kray, the Yakutsk diamond deposits and a number of other deposits. The main trends in the modernization and technical development of open-pit ore extraction methods were outlined in the report. This includes the creation of high-capacity pits (of 25-30 million tons per year and more), based on the utilization of powerful and highly productive mining transport equipment. Scientific research aimed at establishing the basic contours of open-pit fields and the technological methods for their operation is necessary in order to solve this problem.

It is important to develop effective methods for conducting drilling and blasting operations in open-pit mines. As the speaker pointed out, the Mining Institute of the Academy of Sciences USSR is conducting a considerable amount of work along these lines, aimed at establishing rational parameters for drilling machines for drilling through rocks having various degrees of hardness, and aimed at the development of highly effective and low-cost explosive materials (of the "Igdanite" type), which will ensure a high-quality pulverization of ores and an effective operation of mining machinery.

The use of powerful single-shovel excavators (mechanical shovels and drag-lines) is highly important for the effective exploitation of deposits by means of high-altitude benches. The Mining Institute of the Academy of Sciences USSR has developed a rational series of standard dimensions for new single-shovel excavators used for loading and transportation purposes, as well as for excavators with buckets with a capacity of up to 10 to 50 cu m, used in the most economic non-transport mining systems, in which stripped rock formations are transferred by means of excavators into the depleted section of the open-pit mine.

Work done at the Mining Institute has resulted in the establishment of parameters for mining and transport equipment units (rotary and chain excavators, belt conveyers, and swing chutes), necessary for the effective exploitation of many deposits in the USSR during the next 10 years. The introduction of modern open-pit transport means is important, in order to reduce the costs of shipments having a labor input equal to 50-60% of the total volume of mining operations. Considerable work along these lines is being performed at the Mining Institute, aimed at establishing rational parameters for self-discharging railroad cars, dump trucks, electric locomotives and conveyers. The proposed standard dimensions for transport equipment provide a high economy of transportation under various types of mining and technical conditions. Plans are also being made for an extensive use of

hydromechanical means as a method of operation which will ensure a highly efficient exploitation under the conditions prevailing in certain definite types of deposits.

The following persons took part in the discussion of the report presented by N. V. Mel'nikov: B. K. Aleksandrov, Corresponding Member of the Academy of Sciences USSR, Professor M. G. Dombrovskiy (State Committee for Automation and Machine Building under the Council of Ministers USSR), M. M. Sokolovskiy (Gosplan USSR), and I. B. Shlayn (All-Union Scientific Research Institute on Reinforced Concrete).

The general meeting endorsed the basic trends in the modernization and development of the open-pit exploitation method of ore deposits suggested by the speaker, as well as the scientific work on this problem conducted at the Mining Institute of the Academy of Sciences USSR. It was considered advisable that the Mining Institute of the Academy of Sciences USSR, together with institutes subordinate to the Department of Technical Sciences of the Academy of Sciences USSR, conduct work on the following scientific research projects: a. A search for continuous technical operating systems of open-pit mining, which will ensure the automation of all production processes in open pits, including processes used in deposits characterized by complex climatic and technical mining conditions; b. The development of basic premises for the construction of high-capacity combined machinery with a programmed control; c. An effective mining of deposits under complex hydrogeological conditions and located at great depths.

The Mining Institute has been requested to examine the problem concerning the possibility of carrying out scientific work connected with the exploitation of alluvial mineral deposits (placers). The Mining Institute must coordinate its work to a greater extent with other institutes in regard to the open-pit exploitation of ore deposits.

It was decided at the general meeting to request the State Scientific Technical Committee of the Council of Ministers USSR, the Gosplan USSR, and the Committee on Automation and Machine-Building of the Council of Ministers USSR to take the necessary measures aimed at the most rapid adoption of the results of the work done at the Mining Institute of the Academy of Sciences USSR on the open-pit mining of deposits.

Next, a report was presented by N. N. Shumilovskiy, Doctor of Technical Sciences (together with L. V. Mel'tser, Candidate of Technical Sciences), on the scientific fundamentals of automatic control methods involving the use of nuclear radiation.

The automatic control of industrial processes, based on the use of radioactive isotopes and nuclear radiation, is of great importance. According to data provided by the Institute of Economics of the Academy of Sciences USSR, the utilization of radioactive control and automation instruments in industry has enabled the national economy of the USSR to save approximately 500 million rubles in 1958.

Although radioactive automatic control methods are widely used both in the USSR and abroad, the scientific basis of these methods was first worked out in the Soviet Union mostly by scientific personnel of the Academy of Sciences USSR and of the academies of science of union republics.

The speaker pointed out that during the analysis of corresponding equipment, it is necessary to take into account, in addition to the ordinary instrument control errors, also the presence of a probability error caused by the statistical nature of radioactive decay. For this reason, differential and compensating circuits are used, instead of direct conversion circuits, in order to increase the accuracy of measurements. In this connection, the use of compensation circuits with modulated radiation makes it possible to utilize the most effective radiation receivers, such as, for example, scintillation counters. However, in this case, there is a drawback in the fact that the measured radiation flux acts upon the receiver only during one half of the operating cycle and the statistical error is twice as great as in the case of direct conversion circuits.

One of the drawbacks of normal compensation circuits is the presence of a mechanical tracking system which limits the quick operation of the instrument. Therefore, much attention has been given lately to the development of methods which do not require the introduction of a mechanical tracking system into the measuring circuit. Such methods include, for example, the dynamic compensation method (or scanning conversion method), in which the comparison parameter covers all values within the measured area, while the zero element records only the equality moment of the measured parameter and of the comparison parameter.

Although the accurate measurement of the intensity of the radiation flux is a compulsory requirement for the majority of devices of this particular type, it is not an end in itself, since in the final analysis it is not the intensity of the radiation which must be accurately controlled, but rather a certain technical parameter, with which this intensity is connected by means of a certain arbitrary functional relationship.

The speaker showed conditions under which, in various control circuits, a minimum error in the determination of certain technological parameters corresponds to a given error in intensity measurements.

In case of a rapid change in the controlled parameters, it is interesting to study the operation of a measuring device under dynamic conditions from the standpoint of the selection of a minimum activity of the source in case of a given dynamic operational regime. The speaker presented a number of equations, with the aid of which it is possible to determine the optimum parameters of a circuit in case of a given operational regime. In addition to devices, the accuracy of which is determined by the accuracy of the measurement of the intensity of the radiation flux does not have to be considered at all

also play an important role. Such devices are those which operate under relay conditions, in which the only important fact is the presence or absence of a radiation flux, as well as devices operating on the base of a phase, or frequency or time principle. The speaker cited methods for determining the operational reliability and accuracy of circuits belonging to this type.

At the present time, in the field of automatic control devices based on the utilization of radioactive isotopes, some of the comparatively simple devices (thickness gauges, density gauges, level gauges, and relays) have already been studied to a sufficient extent and are ready for series production. At the same time further scientific developments in this particular field require the conduct of basic research aimed at the development of new and relatively more complex control methods. Such methods include methods for the automatic control of the composition of multicomponent mixtures and complex materials, methods of active automatic gamma-ray materiology, methods based on the utilization of controlled neutron fluxes, and certain other methods.

The solution, for example, of such a problem as the automatic continuous non-contact gauging of the composition of complex mixtures, will yield almost revolutionary technical results during the automation of a large number of processes in the chemical, metallurgical, and other industries.

If the chemical composition of a liquid mixture flowing through a pipeline, or of a furnace charge traveling along a conveyer, or of a fused metal, will be continuously checked through a wall and without any contact of the measuring device with the environment, and if, in addition, electrical pulses will be fed to an automatic control device, this will not only result in the elimination of large numbers of laboratory workers, engaged in express analytical work, but will also result in the establishment of an improved system for controlling the quality of production on the basis of a direct control of its quality.

The general meeting endorsed the main results of the work done in connection with the development, study and industrial application of automatic control methods involving the use of nuclear radiation. It was considered advisable to pursue this work in the following directions: 1. To work out the basic scientific principles of automatic control methods involving the use of nuclear radiation, including an analysis of the accuracy of these methods under static and dynamic operating conditions. 2. To work out new methods of automatic control based on the use of radioactive isotopes, and specifically methods for controlling the composition of complex materials and mixtures, the automation of materiological control methods, and methods based on the utilization of controlled neutron sources.

The general meeting noted the insufficient volume of work done in this particular field at the Academy of Sciences USSR. The Bureau of the Department of Technical Sciences of the Academy of Sciences

USSR was requested to examine the problem concerning the speedy organization of a laboratory for the development of automatic control systems based on the use of isotopes and nuclear radiation.

The third report presented at the meeting was that of B. V. Kantorovich, Doctor of Technical Sciences, dealing with the combustion of liquid and solid fuels and aqueous fuel emulsions in a stream of air.

The speaker described the work done in the laboratory headed by him at the Institute of Mineral Fuels of the Academy of Sciences USSR, concerned with the study of the combined basic phenomena occurring in a stream of burning fuel particles, and directed specifically at the extensive application of aqueous fuel emulsions, which will make it possible to successfully utilize large resources of heavy and highly viscous water-containing liquid fuels in all branches of the national economy.

The resolution issued at the general meeting in connection with this report pointed out the great technical importance of the process involving the combustion of a stream of atomized fuel particles. Stream combustion opens up new prospects for the mechanization, automation and development of new and high-intensity fuel combustion processes. Research work on the theory of combustion of a stream of fuel particles takes into account, in addition to chemical reactions, also the movement and the burn up of the reacting gas, nonisothermic conditions of the process, and other phenomena occurring in all actual technical processes associated with the stream combustion of fuel.

A combined study of the entire complex of basic phenomena occurring in a stream of burning fuel particles has resulted in the establishment of new and general laws which make it possible to determine a number of basic characteristics of this process, having a great importance both for a more speedy calculation of presently available fire chambers of industrial furnaces and steam boilers, combustion chambers of engines, gas turbines, etc., as well as in the development of new intensive combustion processes.

The meeting endorsed the basic trends of the theoretical and experimental studies dealing with the theory of stream fuel combustion, and acknowledged the advisability of carrying out further research aimed at developing the theory of combustion of a fuel stream and new efficient processes of fuel stream combustion under a high pressure accompanied by water evaporation within the general reaction area, and of processes involving the combustion of aqueous fuel suspensions and emulsions, including the development of technological processes and their experimental testing.

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